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(20140-00281-US)**REMARKS**

Claims 19-31 and 33-39 are now in the application. Claim 19 has been amended to recite "a slurry consisting essentially of abrasive particles and an oxidizing agent wherein said oxidizing agent has a static etch rate on metal of less than 1000Å per hour" in place of "a slurry comprising abrasive particles and an oxidizing agent wherein said oxidizing agent has a static etch rate on metal of less than 1000Å per hour". The amendments do not introduce any new matter.

The Board presented as a new ground of rejection, the rejection of Claims 19-27 and 33-39 under 35 USC103(a) as being unpatentable over US Patent 5,770,103 to Wang, US Patent 5,804,513 to Sakatani and US Patent 5,968,280 to Ronay. The cited references do not render obvious claims 19-27 and 33-39. As mentioned above the claims now recite "a slurry consisting essentially of abrasive particles and an oxidizing agent wherein said oxidizing agent has a static etch rate on metal of less than 1000Å per hour". Accordingly the claims include those components that are recited in the claim along with those that do not materially affect the basic and novel characteristics of the claims. Accordingly, the claims exclude those materials that materially affect the basic and novel characteristics of the claims such as oxidizing agents having a static etch rate outside the claimed rate such as various oxidizing agents suggested in Wang and in Sakatani. See MPEP 2111.03. The Board found the above claims to be obvious over these references especially because of the use of the transitional term "comprising", which according to the Board, left the claims open to including other additives such as the substituted phenol of Wang and containing additional oxidizing agents including those having static etch rate outside of the claimed range.

In addition, by way of background, the present invention relates to a method for polishing a surface and especially those surfaces employed in microelectronics. The method of the present invention employs a slurry composition that is capable of polishing both metal and silicon dioxide at substantially equal rates (see page 1, lines 7-9). The slurry compositions employed in the method of the present invention comprise abrasive particles and an oxidizing agent having a static etch rate on metal of less than 1000 Å per hour and having a pH of about 5 to about 11.

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As discussed in the specification, the present invention provides a method that is capable of removing the topography and scratches created during the polish of a prior level of metallization.

In the manufacture of a semiconductor device, the wires for the chip in the "back end of the line" (BEOL) are usually formed by the so-called cloisonné process. In this process, the metal is uniformly deposited on the wafer, patterned with a mask, and then etched with a plasma reactive ion etch (RIE) tool to leave the metal isolated in regions where one desires the wires. Then the dielectric material is deposited, and polished using chemical mechanical planarization (CMP) to leave the conductors properly separated. One of the benefits of this process of forming the wires is that since the plasma RIE removes material on a "line of site", it is effective in removing the metal that might be deposited in topography that originated from a process operation at a prior level.

However, to both reduce cost and to utilize different, low-resistance materials for the construction of the metal wires, the cloisonné process is being replaced by the damascene process to form the wires in the BEOL. In this reverse process, the dielectric is first uniformly deposited, patterned with a mask and etched. Then the metal conductor is uniformly deposited such that it forms a conformal film over the entire wafer and fills the patterns that have been etched into the dielectric. Then, using CMP, the excess surface metal is removed to leave the wires filled with metal. One of the problems with this process is since the metal is removed via CMP, which planarizes as it removes the excess material, residual metal can remain in topography that has been created at prior levels. That is, if there is a scratch or erosion in the dielectric, the metal will fill that void and cannot be removed easily via CMP without considerable over polish and the resulting damage that it introduces.

A specific example where this change in methodology of creating the wires is necessary is the manufacture of semiconductor devices with copper BEOL wiring. Since there is no viable process for etching copper currently available, it is a preferred technique to form the lines with the damascene process. In such a case, the local wiring of the semiconductor devices (that is at the lowest levels of the chip), usually utilizes tungsten as the conductor, which is then connected to the more global wiring in the BEOL, which is made of copper. In this specific example, it is

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found that erosion or scratching of the oxide dielectric at the last tungsten level replicates up and to the ensuing copper levels. The areas of erosion then lead to "puddles" of residual copper, and the scratches leave "stringers" of the copper, each of which if not removed at the copper CMP step would cause short-circuits. If these puddles or stringers are removed during the copper CMP step, it adds considerable processing time for the "overpolish."

Since the removal of all of the surface metal is essential to eliminate the short circuits and because the damascene process is sensitive to both the material and underlying topography of those materials, it is clear that the surface of the wafer must be highly planar (i.e., no existing topography) prior to the deposition of the metal. The obvious method of achieving this polarity is to polish the dielectric into which the metal will be inlaid to create a smooth, scratch-free film prior to metal deposition. However, this has the disadvantage that it would necessitate additional process steps (polishing and cleaning) and would result in a highly variable dielectric, and hence, conductor thickness. This would cause the undesirable result of having a variable resistance for the circuit.

The present invention overcomes problems in the prior art. More particularly, as discussed above, the present invention employs a slurry composition that is capable of removing the topography and scratches created during the polish of a prior level metallization. The slurry composition employed according to the present invention, as discussed above, can polish both metal and silicon at equal or substantially equal rates.

Wang fails to render obvious the present invention, since among other things, Wang fails to suggest selecting a pH of about 5 to about 11 along with selecting an oxidizing agent having a static etch rate on metal of less than 1000 Å per hour. On the other hand, Wang suggests employing a slurry having a pH of 1 to about 7 and employing an oxidizing agent such as nitrates, iodates, chlorates, perchlorates, chlorites, sulphates, persulphates, peroxides, ozonated water and oxygenated water. Many of these oxidizing agents exhibit etch rate significantly greater than that recited in the claims. Moreover, none of the examples in Wang employ a slurry composition having a pH of at least about 5 along with an oxidizing agent having a static etch rate on metal of less than 1,000 Å per hour. It has been found according to the present invention that both the pH and type of oxidizing agent, are judiciously selected in order to achieve the

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results obtainable by the present invention and namely to obtain polishing of both metal and silicon dioxide at equal or substantially equal rates.

On the other hand, the polishing compositions and technique suggested by Wang result in achieving much higher metal etching rates. For instance, Wang has polishing rates of nearly 4000 Å/minute (calculated from their film stack divided by polish time in example 1 and 2) which is obtained by having a high chemical component of the slurry, which is true for the pH range discussed in the examples (<5).

Contrary to the objectives of Wang, the purpose of the slurry used in the present invention is to keep the W rate low, and to make the W:BPSG selectivity = 1, by adjusting the pH higher than other slurries. According to the present invention, the pH is between 5 and 11 to make the selectivity equal or substantially equal. Needless to say, the tungsten polishing rate according to the present invention is also a factor of about 20 less than that desired by Wang.

The objective of Wang is to achieve very high polishing rates for metal as contrasted to the results obtainable by the present invention. The objective of Wang is to provide a slurry for removing titanium and other metals while suppressing the rate of removal of silicon (for instance, see column 3, lines 1-7 thereof). To etch metal and silicon dioxide at substantially the same rate would be contrary to the desires of Wang.

Furthermore, the process constituents such as the abrasive and the oxidizing agent used by Wang, *et al.* are not identical to those claimed since nothing in Wang leads to employing a composition having the same abrasive, oxidizing agent, and pH as recited in the present claims from all of the possible combinations included within the suggestions of Wang.

Sakatani does not overcome the above discussed deficiencies of Wang with respect to rendering obvious the present invention. Sakatani suggests employing a pH of about 7 or less or preferably about 5 or less along with an oxidizing agent which can be hydrogen peroxide, iron (III) nitrate, iodic acid, iodate, perchloric acid and perchlorate. The preferred oxidizing agents are hydrogen peroxide and iron (III) nitrate. Included among the oxidizing agent such as the hydrogen peroxide and iron (III) nitrate are those that have polishing rates on metals significantly greater than the 1000 Å per hour recited as a maximum in the claims. In addition, none of the

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examples in Sakatani employ a pH of at least about 5 along with an oxidizing agent having a low static etch rate of less than 1000 Å per hour as recited in the claims. The only examples in Sakatani employing a pH of above 5 are examples 4 and comparative example 8, both of which employ hydrogen peroxide, a strong oxidizer, as the oxidizing agent (for instance, see page 7, line 27-29 of the specification). Moreover, the objective of Sakatani is to have high etch rates for the metal as compared to silicon dioxide. Along these lines, see table 1 and 2 of Sakatani. Accordingly, to include the slurry compositions employed according to the present invention would be contrary to the objectives of Sakatani. Nothing whatsoever in Sakatani would leave one skilled in the art to select a slurry composition having a pH of at least 5 and an oxidizing agent having a static etch rate on metal of less than 1000 Å per hour among all the possible combinations of pH and oxidizing agents suggested in Sakatani. If anything, one skilled in the art would be lead to employ an oxidizing agent having an etch rate on metal as high as possible since that is an objective of Sakatani.

Ronay does not overcome the above discussed deficiencies of Wang and Sakatani with respect to rendering obvious the present invention. Ronay was relied upon by the Board for a disclosure that it was known to polish surfaces comprised of metals, such as tungsten, aluminum, copper, tantalum, tantalum nitride, titanium and titanium nitride, and dielectric materials using aqueous slurry compositions which can include such abrasives as alumina, silica, ceria, and zirconia, and such oxidizing agents as potassium iodate, ammonium cerium nitrate and potassium ferricyanide, wherein a primary slurry can contain alumina at an acidic pH and a secondary slurry can contain silica at a more neutral pH. However, Ronay fails to suggest the selection of the types of oxidizing agents as recited in the claims as amended. Moreover, the rejection employing Ronay has been overcome by the filing of the verified statement that the claimed invention and that of Ronay were commonly owned at the time the present invention was made and are now currently commonly owned.

The cited references fail to provide the degree of predictability of success of achieving the properties attainable by the present invention needed to sustain a rejection under 35 USC 103. See *Diversitech Corp. v. Century Steps, Inc.* 7 USPQ2d 1315 (Fed. Cir. 1988), *In re Mercier*, 187 USPQ 774 (CCPA 1975) and *In re Naylor*, 152 USPQ 106 (CCPA 1966).

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Moreover, the properties of the subject matter and improvements which are inherent in the claimed subject matter and disclosed in the specification are to be considered when evaluating the question of obviousness under 35 USC 103. See *Gillette Co. v. S.C. Johnson & Son, Inc.*, 16 USPQ2d. 1923 (Fed. Cir. 1990), *In re Antonie*, 195, USPQ 6 (CCPA 1977), *In re Estes*, 164 USPQ (CCPA 1970), and *In re Papesch*, 137 USPQ 43 (CCPA 1963).

No property can be ignored in determining patentability and comparing the claimed invention to the cited art. Along these lines, see *In re Papesch*, supra, *In re Burt et al*, 148 USPQ 548 (CCPA 1966), *In re Ward*, 141 USPQ 227 (CCPA 1964), and *In re Cescon*, 177 USPQ 264 (CCPA 1973).

It is noted that claims 28-31 have not been included in the above rejection of claims.

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

In the event that the examiner believes that an interview might advance the prosecution of this application, the undersigned is available at the phone number noted below. The Director is hereby authorized to charge any fees, or credit any overpayment, associated with this communication, including any extension fees, to CBLH Deposit Account No. 22-0185.

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Respectfully submitted,

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